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INSTRUCTION MANUAL

FSR
(Frequency Shift Reflector)

Model 6402-0001

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BUFFALO, NEW YORK

TM-0536

INSTRUCTION MANUAL

FSR Model 6402-0001

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INTRODUCTION

This manual comprises operation, installation, and maintenance instructions for the FSR* (Frequency Shift Reflector), Sierra Research Corporation Model 6403-0001. The FSR is a zero-delay, offset-frequency beacon which provides an accurate, reliable point target for range calibration. By virtue of its high signal-to-clutter ratio, the FSR furnishes a more clearly defined and readily identifiable target return.

*Patent No. 3108275

Figure 1. FSR Model 6403-0001

SECTION I

DESCRIPTION AND THEORY OF OPERATION

A. DESCRIPTION

The FSR, Sierra Research Corporation Model 6402-0001 (see figure 1), provides a distinct target return for radar transmissions in the frequency range of 5.4 - 5.9 gc. This unit consists of a 3-foot radome-covered parabolic antenna, a modulator driver, and an internally-fed phase modulator. It is furnished with mounting hardware for pole installation.

B. THEORY OF OPERATION

Figure 2 illustrates the basic principle of the FSR. A direct signal (F_d) impinges upon an antenna, in this case shown as a piece of flared waveguide. Connected to this antenna is a non-linear device shown as a varactor. Connected to this varactor is a modulating source (F_m).

The modulating signal (F_m) switches the varactor on and off at an F_m rate. This effectively shifts the back wall of the phase modulator one-half wavelength, thereby producing sideband components at $F_d \pm F_m$. These frequency-shifted sidebands are reflected back to the F_d source, hence the name "Frequency Shift Reflector."

The basic function of the modulator is to shift the FSR echo frequency far enough from the fundamental so that when the local oscillator of the receiver is tuned to accept that frequency, the receiver adequately rejects "skin" return signals. The rejection characteristics depend primarily on the selectivity of the i-f strip and the characteristics of the magnetron output spectrum.

The FSR antenna is a 3-foot parabolic reflector with a nominal gain of 31 db over an isotropic radiator at C-band frequencies. It has a beamwidth of 5 degrees at the half-power points.

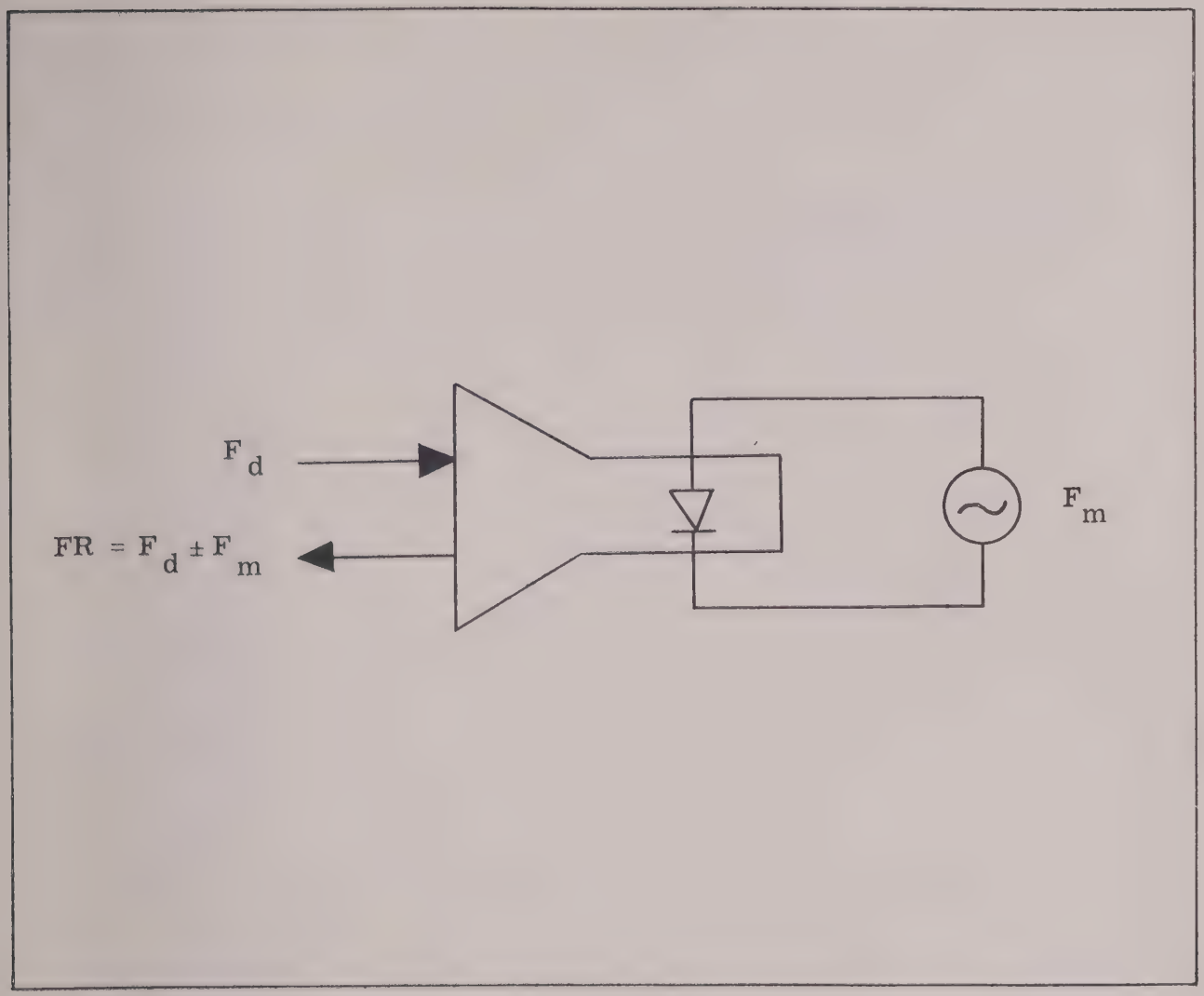


Figure 2. FSR Block Diagram

The modulation feed consists of a varactor mounted in a waveguide holder, with a coaxial connector through which the modulating frequency is applied to the varactor. (See figure 3.)

The modulator driver in this case is a 105-mc crystal-controlled r-f source which delivers a nominal 200 ma into a 50-ohm load. The modulator driver is mounted on the phase modulator (see figure 3).

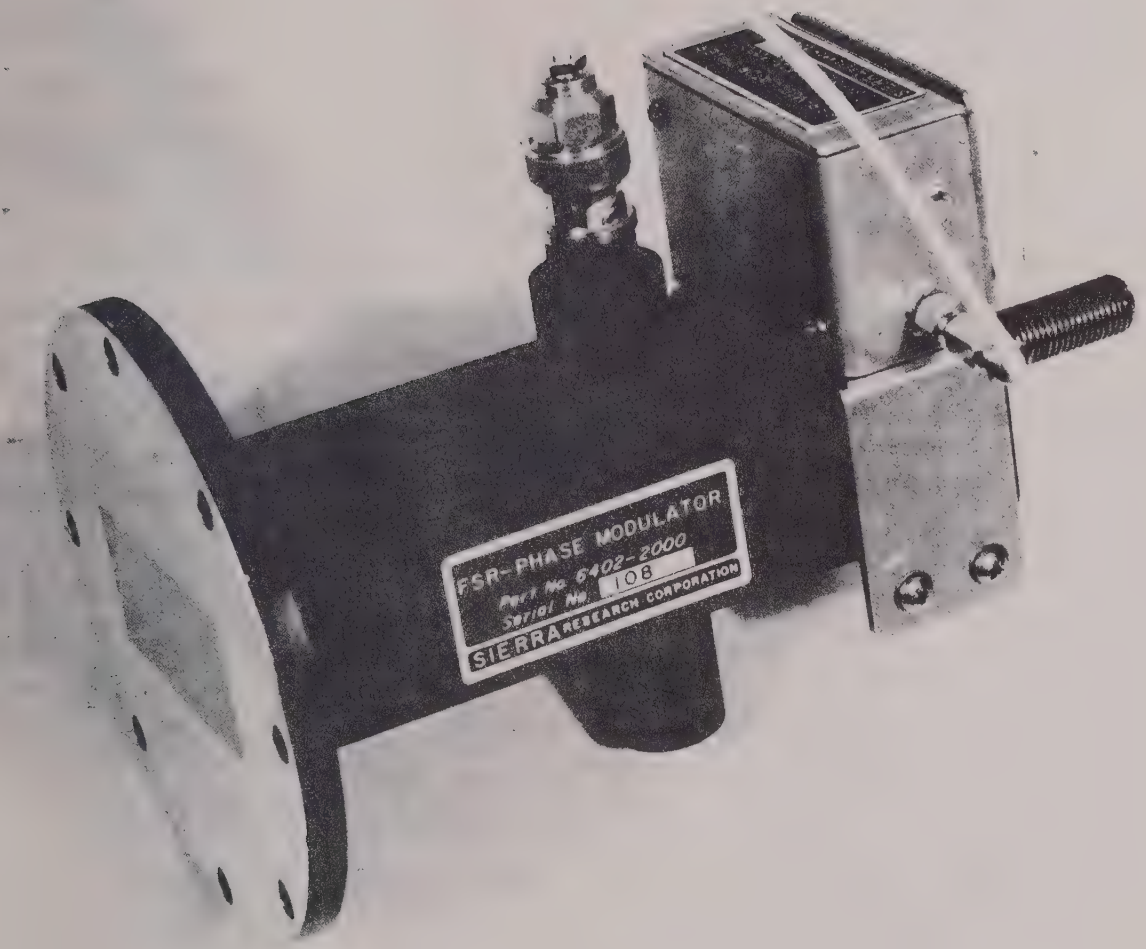


Figure 3. Phase Modulator and Modulator Driver

SECTION II

INSTALLATION AND MAINTENANCE

A. INSTALLATION

The FSR is designed for mounting to a 1-1/2 to 2-1/2 inch pole and is equipped with the mounting hardware. Figure 6 pictures the FSR mounted to a pole. Azimuth alignment is made by rotating the FSR about the pole. Vertical alignment is made by adjusting the length of threaded rod from the pole mount to the FSR mount ring. When desired alignment is achieved, tighten all mounting hardware securely. If a telescope is used as the boresight aid it should be removed from the FSR when alignment is completed. The lens dust covers should be put in place and the telescope be stored indoors when not in use.

The Frequency Shift Reflector requires alignment of the FSR antenna beam with the radar beam for maximum performance. Sierra Research Corporation recommends that one of three methods be used, radio communication, optical or aural.

The FSR can be boresighted with the aid of a two-way radio. The FSR is adjusted according to the voice commands of the radar operator for maximum FSR return.

Sierra Research Corporation can supply boresighting accessories to perform boresight alignment (with the optical and aural methods). If optical boresight is the chosen method, Sierra Research provides a telescope and detachable mount on the FSR at time of delivery. In this case a telescope is optically sighted at the factory to provide alignment of the FSR antenna beam within the 3 db half power joints. The detachable mount is of a design that allows the telescope to be detached and remounted without losing the accuracy of the boresight. The FSR is positioned to center the cross hairs of the telescope on the radar antenna upon installation. The telescope has a magnification of x10 and a field of view of 120 feet at 1000 yards.

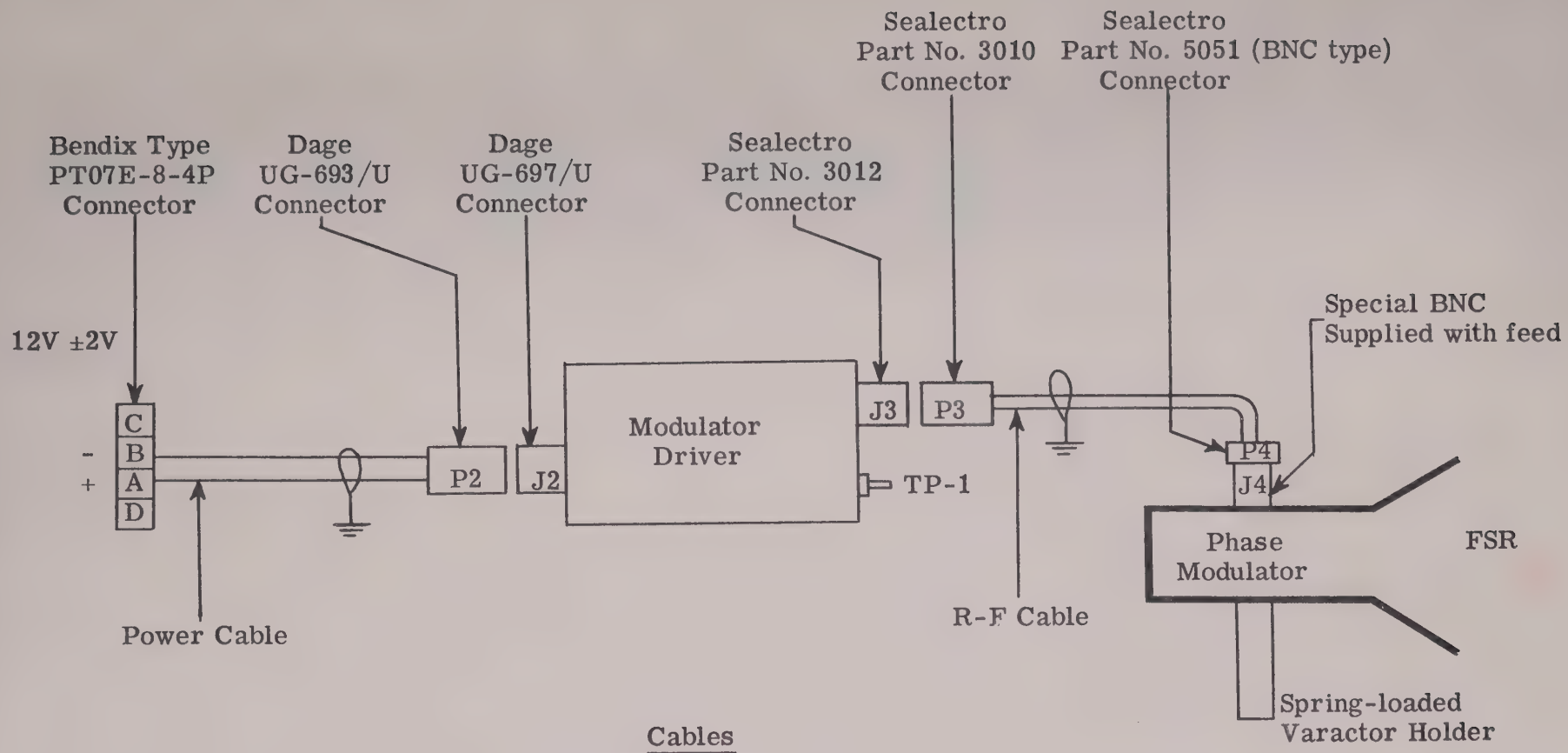
A video amplifier which Sierra Research Corporation has designated as RADLOC is used to boresight the FSR antenna by the aural method. The RADLOC is a video amplifier which utilizes the detection properties of the varactor, in the phase modulator, to provide an aural indication relative to FSR alignment. The RADLOC is packaged in a container 4 x 2-1/2 x 2 inches, weighing 8 ounces. It has a self-contained battery power supply, a volume

control/ON-OFF switch and a hearing aid type of head phone. To use the RADLOC, the FSR radome is dismounted by removing the retaining nut at the front of the radome. The modulator driver cable is removed from the modulator and the RADLOC is connected to the modulator by a suitable length of coaxial cable; then with the radar illuminating the FSR site, the installer points the FSR to give maximum audio output from the RADLOC.

B. MAINTENANCE

In the event the FSR becomes inoperative, the operator should perform the following steps to isolate the defective part:

1. Check that the power supply or battery is properly connected and is within the range of 10 to 12 volts dc.
2. Remove the radome by removing the retaining nut at the front of the radome.
3. Measure the voltage between test point TP1 on the phase modulator driver and the chassis. This voltage should read between -0. 5 and -2 volts. A voltage reading within these limits indicates proper operation of the FSR electronics.
4. Check for existance of -12 vdc on the connector P2.
5. Remove the cable between J3 and J4 and check for continuity or shorts.
6. If the above checks indicate proper supply voltages and cable continuity, the phase modulator or modulator driver are defective. Both the modulator driver and modulator are sealed units which are not intended to be repaired in the field. For optimum performance it is recommended that the phase modulator and modulator driver be replaced as a matched pair. The defective units should be returned to the factory for repair.
7. To replace the phase modulator and modulator driver, carefully remove the four nuts which secure the phase modulator to the primary horn feed. Install the new unit being careful to install it with the H plane of the phase modulator aligned with the H plane of the feed horn. When replacing the phase modulator care should be taken not to disturb the alignment of the feed horn relative to the antenna.



Cables

12-Volt Power Cable Type RG 122/U

R-F Cable Teflon Type RF 196/U

Figure 4. FSR Connections For Use

SECTION III

OPERATION

This section describes the operation of a typical radar set when used with a Frequency Shift Reflector.

Assuming an intermediate frequency of 60 mc, the local oscillator (L.O.) must be tuned 60 mc above the FSR return. Figure 5(a) illustrates the spectrum for conventional skin reception. Figure 5(b) illustrates the sidebands produced by the 105-mc modulation process. The L.O. is tuned to allow reception for maximum FSR return.

To insure that an actual FSR return is being received, it is suggested that the FSR be turned off while observing the signal.

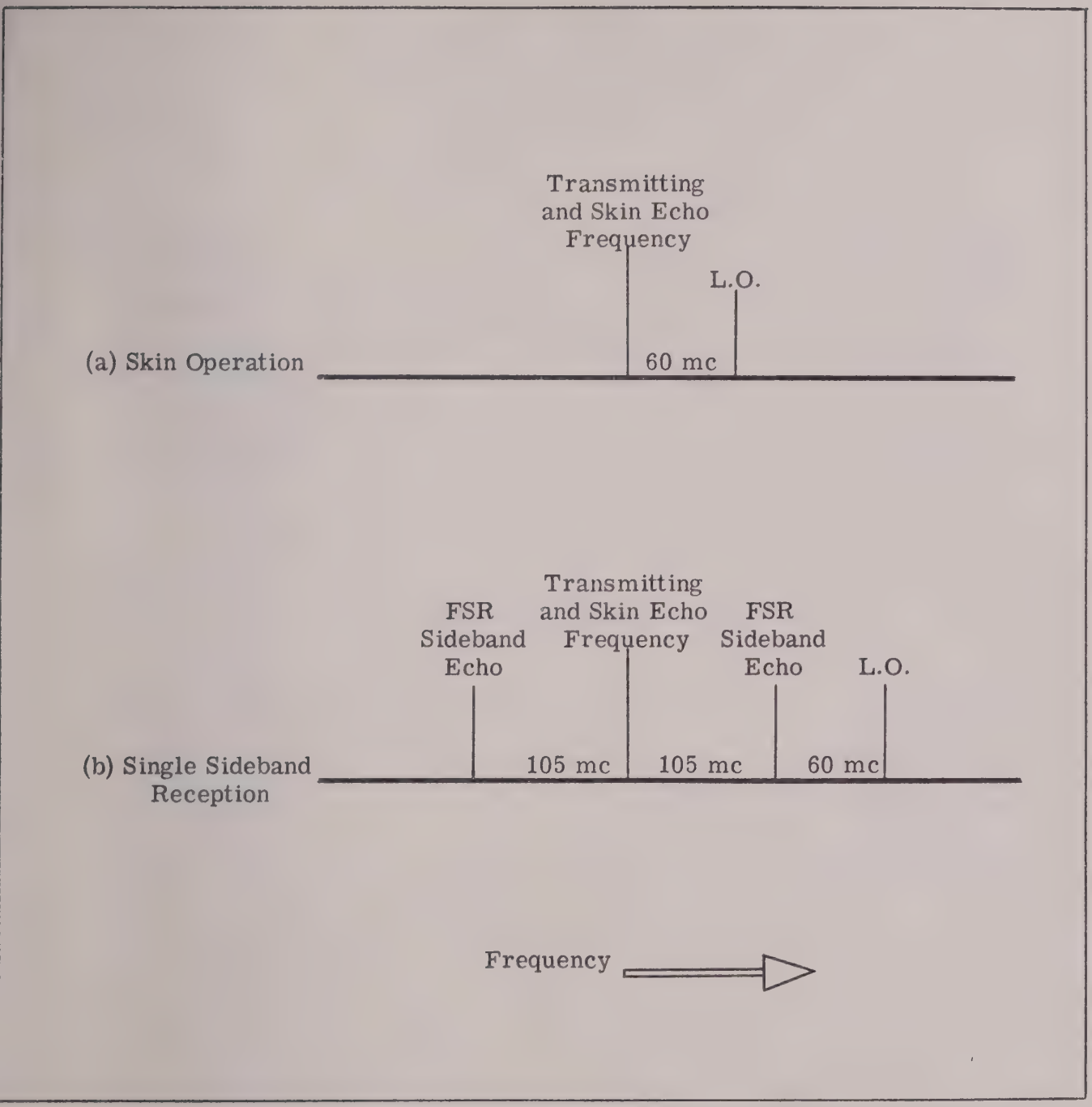


Figure 5. Line Frequency Spectrum of FSR and Skin Echo

SECTION IV
LIST OF MAJOR COMPONENTS

FSR Model 6402-0001

Component	Part Number
Antenna Assembly	6402-1000-1
Phase Modulator	6402-2000-1
Modulator Driver, 75 mc	6402-3000-1
Varactor Diode	6402-4000-1

RECOMMENDED SPARE PARTS

Phase Modulator/Driver (Factory matched pair)	6402-2000-1 and 6402-3000-1
Power Cable	6402-2025-1
Signal Cable	6401-2020-1

APPENDIX A

SPECIFICATION

FSR Model 6402-0001

C BAND

ANTENNA	
Type	Parabolic, Radome Covered
Gain	31 db nominal. 26 db minimum
Diameter	3 feet
Beamwidth	5 deg. nominal, 3.5 deg. minimum
MODULATION EFFICIENCY:	-10 db
5.4- 5.9 kmc at -33 dbm incident power on FSR	
MAXIMUM POWER RATING:	
Maximum incident peak power on FSR for operation without damage to modulator	+13 dbm peak at 0.01 duty cycle maximum
MODULATOR DRIVER:	
Type	Crystal-controlled
Frequency	45 mc to 120 mc (choice of one fixed)
Stability	0.1%
MODULATOR:	Varactor
ENVIRONMENTAL:	
Temperature	-20 deg. F. to +150 F.
Altitude	Up to 30,000 feet above MSL
Relative Humidity	0 to 100%
Sunshine	Able to withstand direct solar radiation
Dust	Can withstand conditions normally found in arid regions
Wind	Operable in 50 kt. wind - will withstand 80 kt. wind
Mounting	Suitable to clamp to 2-1/2 inch pipe
Power Requirement	12 vdc at 150 ma

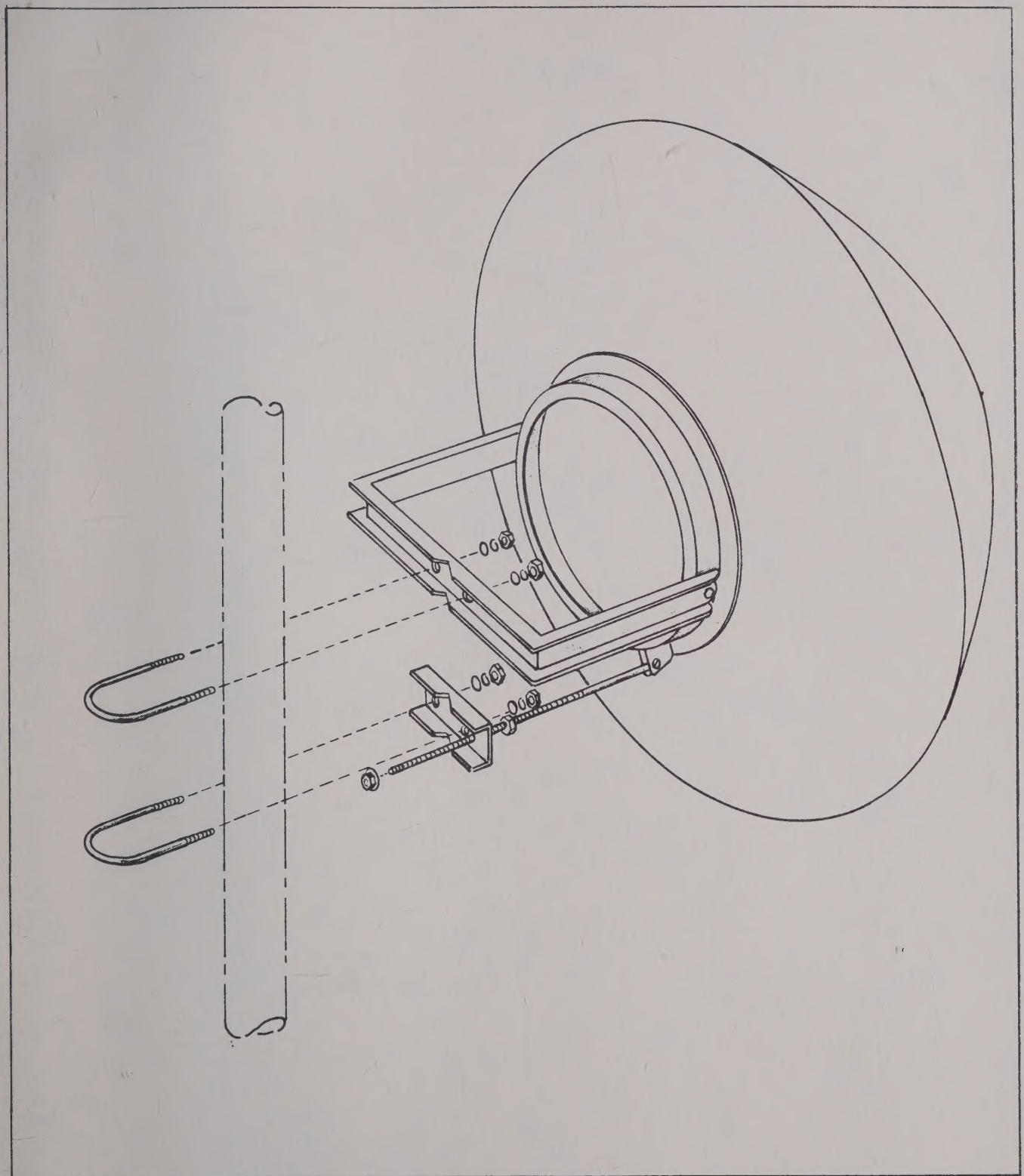


Figure 6. Mounting Assembly